No. 00-1167

NOV 15 2001

IN THE

Supreme Court of the United States

TAHOE SIERRA PRESERVATION COUNCIL, INC., *et al.*,

Petitioners,

v.

TAHOE REGIONAL PLANNING AGENCY, *et al.*,

Respondents.

ON WRIT OF CERTIORARI TO THE
UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

BRIEF OF *AMICI CURIAE* SCIENTISTS IN SUPPORT OF RESPONDENTS

KARL M. MANHEIM*
DANIEL P. SELMI
Attorneys for Amici Curiae Scientists
919 S. Albany Street
Los Angeles, California 90015
(213) 736-1106

**Counsel of Record*

170582

COUNSEL PRESS
(800) 274-3321 • (800) 359-6859

BEST AVAILABLE COPY

TABLE OF CONTENTS

Page

Table of Cited Authorities iii

Interest of *Amici Curiae* 1

Identity of *Amici* 2

Statement of Facts 6

Argument 7

I. The Body Of Scientific Evidence On Lake Tahoe's Ecology Documents The Danger Posed To The Lake And Supports The District Court's Factual Findings Concerning The Need For The Moratorium. 7

A. Scientists Have Compiled a Comprehensive Body of Knowledge About Lake Tahoe and About the Ecological Damage to the Lake. 7

B. Five Principal Scientific Facts Concerning the Lake's Ecology, Which the District Court Recognized in Its Factual Findings, Underlie the Threats to the Lake. 8

1. Increased Deposits of Nitrogen and Phosphorus Are Causing the Lake To Change From an Oligotrophic to a Eutrophic Condition. 8

Contents

Page

2. Human Development in the Lake Tahoe Basin is Causing The Damaging Increase in Nutrient Levels. 10

3. Development of "High Hazard Lands" and "Stream Environment Zones" Poses the Greatest Threat to the Lake. 13

4. If These Adverse Ecological Changes Had Not Been Addressed, They Would In Practical Terms Have Become Irreversible. 15

5. The Change to the Lake's Color Is Merely One Visible Sign of the Fundamental Transformation of the Lake's Ecology. 16

II. The Scientific Evidence Of The Lake's Increasing Degradation Complicates The Planning Response And Justifies The Need For A Moratorium In Which To Complete That Planning. 17

Conclusion 21

TABLE OF CITED AUTHORITIES

Page

Cases:

City of Dallas v. Crownrich, 506 S.W.2d 654 (Tex. App. 1974) 20

Downham v. City Council of Alexandria, 58 F.2d 784 (E.D. Va. 1932) 20

Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992) 17, 18, 20

Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 (1922) 18

State ex rel. SCA Chemical Waste Services, Inc. v. Konigsberg, 636 S.W.2d 430 (Tenn. 1982) 20

Other Authorities:

Robert G. Bailey, *Land Capability Classification of the Lake Tahoe Basin, California-Nevada* (U.S. Dep't of Agriculture, Forest Service) (1974) ... 14

Earl R. Byron and Charles R. Goldman, *Land-Use and Water Quality in Tributary Streams of Lake Tahoe, California-Nevada*, 18 J. of Envtl. Quality 84 (1989) 12, 13, 14

Cited Authorities

Page

Robert N. Coats and Charles R. Goldman, *Patterns of Nitrogen Transport in Streams of the Lake Tahoe Basin, California-Nevada*, 37 Water Resources Research 405 (2001) 10

Gerald A. Cole, *Textbook of Limnology* 192, Table 9-2 (4th ed. 1994) 8

Thomas Dunne and Luna B. Leopold, *Water in Environmental Planning* (1978) 11, 13

W. Thomas Edmondson, *The Uses of Ecology: Lake Washington and Beyond* (1991) 8

Charles R. Goldman, *Anthropogenic Impacts on Oligotrophic Lake Systems Emphasizing Lakes Tahoe and Baikal*, in *Environmental Protection and Lake Ecosystems* (H. Sund and Y. Xiaogan eds. 1994) 16

Charles R. Goldman, *Primary Productivity, Nutrients, and Transparency During the Early Onset of Eutrophication in Ultra-Oligotrophic Lake Tahoe, California-Nevada*, 33(6 part 1) J. of Limnology and Oceanography 1321 (1988) 17

Charles R. Goldman and Alexander J. Horne, *Limnology* (1983) 8, 9

Cited Authorities

Page

Charles R. Goldman, Alan D. Jassby, and Scott H. Hackley, *Decadal, Interannual and Seasonal Variability in Enrichment Bioassays at Lake Tahoe, California-Nevada, USA*, 50 (7-8), Can. J. Fish, Aquat. Sci. 1489 (1993) 10

Lorin K. Hatch, John E. Reuter and Charles R. Goldman, *Stream Phosophorus Transport in the Lake Tahoe Basin, 1989-1996*, in *Environmental Monitoring and Assessment*, 69 Environmental Monitoring and Assessment 63 (2001) 12

Alexander J. Horne and Charles R. Goldman, *Limnology* (2d ed. 1994) 15

T. Hirose and N. Kurmoto, *Stream Water Quality as Influenced by Land Use Patterns in the Kakioka Basin, Japan*, 10 J. Environ. Qual. 184 (1981) .. 11

G. Evelyn Hutchinson, *A Treatise on Limnology, Vol. 1* (1957) 9, 15

Alan D. Jassby, Charles R. Goldman, John E. Reuter, and Robert C. Richards, *Origins and Scale Dependence of Temporal Variability in the Transparency of Lake Tahoe, California-Nevada*, 44(2) Limnology and Oceanography 282 (1999) 9, 17

Cited Authorities

Page

Alan D. Jassby, Charles R. Goldman, John E. Reuter, Robert C. Richards, and Alan C. Heyvaert, *Lake Tahoe: Diagnosis and Rehabilitation of a Large Mountain Lake*, in Great Lakes of the World; Food-Web, Health and Integrity (2001) 7

Julian Conrad Juergensmeyer and Thomas E. Roberts, *Land Use Planning and Control Law* (1998) 20

Luna B. Leopold, M. Gordon Wolman, and John P. Miller, *Fluvial Processes in Geomorphology* (1964) 11, 14

W.M. Lewis, J.F. Saunders III, D.W. Crumpacker, Sr. & C. Brendecke, *Eutrophication and Land Use: Lake Dillon, Colorado* (1984) 11

Stanford L. Loeb, *Algal Biofouling of Oligotrophic Lake Tahoe: Causal Factors Affecting Production*, in *Algal Biofouling* (L.V. Evans and K.D. Hoagland ed. 1986) 9

R.C. Loehr, *Characteristic and Comparative Magnitude of Non-point Sources*, 46(8) J. Water Pollut. Control. Fed. 1849 (1974) 11

L. Minder, *Studien Uber den Sauerstoffgehalt des Zurichsees*, 3 Arch. Hydrobiol. Suppl. 107 (1923) 15

Cited Authorities

Page

Tahoe Regional Planning Agency, *Study Report for the Establishment of Environmental Threshold Carrying Capacities* (October 1982) 11

John R. Vallentyne, *The Algal Bowl: Lakes and Man*, 2 Misc. Special Publ., Fisheries and Marine Service, Environment Canada (1974) 15

Robert G. Wetzel, *Limnology: Lake and River Ecosystems* (2001) 7

INTEREST OF *AMICI CURIAE*[1]

A substantial body of scientific knowledge about the ecology of Lake Tahoe formed the backdrop both for the land use moratorium now being considered by this Court and for the District Court's decision. That knowledge plainly revealed the peril that the lake faces, and the difficult planning choices confronted by Respondent Tahoe Regional Planning Agency ("TRPA").

The knowledge on Lake Tahoe differs substantially from that available in the mid-1960's, when concern about changes to the lake first arose. There now exists a well-developed understanding of the processes that are affecting the lake and the likely outcome if current trends continue. *Amici* are scientists from throughout the United States and abroad who have special knowledge of these scientific issues concerning Lake Tahoe. They have devoted their professional lives to the study of natural resources such as Lake Tahoe, with particular emphasis on the ecological effects of pollution on those resources.

This scientific information, generally reflected in the District Court's findings of fact, leads to a single conclusion: the lake environment has deteriorated rapidly, and the lake was and continues to be at a critical point in its history. Unless regulatory action arrests current trends, the future of the lake's crystalline clarity is in grave doubt.

---

1. Pursuant to Rule 37.3(a) of the Supreme Court's Rules, this brief is filed with the consent of all parties and, such consents have been lodged with the Court. Pursuant to Rule 37.6, *Amici* affirm that no counsel for a party authored this brief in whole or in part, and that no person or entity, other than *amici*, their counsel, and their offices, contributed monetarily to the preparation or submission of this brief.

The scientific information confirms the need for the planning moratorium undertaken by Respondent. Given the ecological state of Lake Tahoe, the moratorium was essential to developing a land use plan that would minimize further harm to the lake while allowing some development in a manner that would not jeopardize the lake's future. Those choices were extraordinarily important and difficult. Thus, it is not surprising that, as the District Court expressly found, Respondent could not have undertaken its regulatory efforts more rapidly than it did in this case.

Additionally, the moratorium prevented an interim "rush to development" before a land use plan could be written and adopted to guide future development. If that "rush" had occurred, it could only have greatly decreased the chances of saving the lake.

Amici submit that the Court should carefully consider these consequences of the scientific knowledge. They strongly suggest the importance of preserving the right of Respondent TRPA to employ a temporary moratorium where essential without fear of liability.

IDENTITY OF *AMICI*

Amici are as follows:

Thomas Dunne is a Professor at the Donald Bren School of Environmental Science and Management, University of California, Santa Barbara. Dr. Dunne conducts field research and theoretical studies of watersheds, hillslope processes, and fluvial geomorphology, with application of hydrology and geomorphology to landscape management. He directs major field research projects in

Kenya and in the Amazon River Basin, Brazil. He is a member of the National Academy of Sciences.

Grachev Mikhail Alexandrovich is correspondent member of the Russian Academy of Sciences, Director of the Limnological Institute of the Siberian Branch of RAS, and organizer of the Baikal International Center for Ecological Research. Professor Grachev directs multi-disciplinary research on the greatest and most ancient fresh-water body on earth, Lake Baikal, in East Siberia. He has authored or co-authored more than 120 scientific papers, and is the winner of the State Award of Russia and of the Karpinsky Award donated by the German Toepfer Foundation. He is directly involved in studies of the changes in the ecological system of Lake Baikal due to changing climate and environment.

Luna B. Leopold is Professor Emeritus of Earth Science and of Landscape Architecture at the University of California, Berkeley. Dr. Leopold is the former Director of Water Resources of the United States Geological Survey. Dr. Leopold is a recipient of the National Medal of Science and is a member of the National Academy of Sciences. He has authored numerous books and journal articles in the fields of hydrology and geomorphology, and their applications in the fields of land use and environmental management.

Gene B. Likens is founder and Director of the Institute of Ecosystem Studies at the New York Botanical Garden, Millbrook, New York. Dr. Likens is credited with the discovery and illumination of the problem of acid rain in North America. He has received the prestigious Tyler Prize for Environmental Achievement. He has written

or edited 14 books and more than 400 research papers. Dr. Likens also holds faculty appointments at Yale, Rutgers, and Cornell Universities, and is a member of the National Academy of Sciences.

John Melack is a professor in the Bren School of Environmental Science and Management and in the Department of Ecology, Evolution and Marine Biology at the University of California, Santa Barbara. Dr. Melack has a research program in limnology, biogeochemistry, aquatic ecology and remote sensing, including active studies of alpine and saline lakes in the Sierra Nevada. He has published over 170 scientific papers. Currently, he is president of the International Society for Salt Lake Research, is a member of the National Academy of Sciences Committee on Geophysical and Environmental Data, and is a member of the Board of Directors of the American Society of Limnology and Oceanography.

Glenn C. Miller is a Professor of Environmental and Resource Science at the University of Nevada, Reno, and Director of the Graduate Program in Environmental Sciences and Health. He is also the Director of UNR's Center for Environmental Sciences and Engineering. His research interests center on the fate and transport of organic compounds in water, soils and the atmosphere. Current areas include studies on emissions of hydrocarbons from watercraft at Lake Tahoe. He is a member of the American Chemical Society, the American Association for the Advancement of Science, and the American Geophysical Union.

Peter B. Moyle is a Professor in the Department of Wildlife, Fish, and Conservation Biology at the

University of California, Davis. Dr. Moyle is an expert in the ecology and conservation of freshwater fishes, with a special interest in threatened and endangered populations in California. Much of his research has concerned fishes of the Sierra Nevada, California. He is author of Inland Fishes of California (2d ed. 2002), the definitive review of the biology of California fishes.

Max Tilzer is Professor of Aquatic Ecology, Faculty of Biology, Universitat Konstanz, Germany. Dr. Tilzer directed the Limnological Institute in Konstanz from 1980 to 1992 and served as principal investigator of the special research project "Cycling of Matter in Lake Constance (1986-1992)." He also served as Director of the Wegner Institute for Polar and Marine Research, Bremerhaven. He is currently a member of the German Advisory Council on Global Change.

Eugene B. Welch is Professor Emeritus of Civil and Environmental Engineering at the University of Washington. Dr. Welch is a recognized expert in the field of water quality management. He is a co-founder and past president of the North American Lake Management Society and past president of the Washington State Lake Protection Association. He and his students have published more than 95 peer reviewed research papers on limnology and lake management. Dr. Welch is author of the text Ecological Effects of Wastewater and co-author of the treatise, Restoration and Management of Lakes and Reservoirs, both in their second edition.

Robert G. Wetzel is Professor of Environmental Science and Engineering at the University of North Carolina, Chapel Hill, and Erlander Professor at the University of

Uppsala, Sweden (lifetime appointment). Dr. Wetzel is currently General Secretary of the International Association of Theoretical and Applied Limnology and Oceanography, and is on the board of the Ecological Society of America. He is an elected member of the American Academy of Arts and Sciences, and the Royal Danish Academy of Sciences. He has authored or co-authored 16 books and has over 400 articles in scientific journals and books.

M. Gordon Wolman is Professor in the Department of Geography and Environmental Engineering at the Johns Hopkins University, Baltimore, Maryland, where he also holds a joint appointment in the Department of Environmental Health Sciences. Dr. Wolman is a member of the National Academy of Sciences, where he has served on numerous committees and boards, and is a past president of the Geological Society of America. He is also a member of the Geophysical Union, where he is a past president of the Section on Hydrology. Dr. Wolman has held visiting appointments at a variety of institutions, including the Universities of Texas, Wisconsin, London, Virginia, Arizona, and Washington. Dr. Wolman's principal research interests are in the areas of geomorphology, river channel processes, hydrology, Quaternary geology, and physical geography.

STATEMENT OF FACTS

Amici adopt the Statement of Facts in the brief of Respondents.

ARGUMENT

I. THE BODY OF SCIENTIFIC EVIDENCE ON LAKE TAHOE'S ECOLOGY DOCUMENTS THE DANGER POSED TO THE LAKE AND SUPPORTS THE DISTRICT COURT'S FACTUAL FINDINGS CONCERNING THE NEED FOR THE MORATORIUM.

A. Scientists Have Compiled a Comprehensive Body of Knowledge About Lake Tahoe and About the Ecological Damage to the Lake.

Since the late 1960's, independent scientists from academia and from federal and state agencies have intensively studied the Lake Tahoe Basin. Both the Tahoe Research Group, led by Dr. Charles Goldman (a witness for Respondents in this case), and the State/Federal Tahoe Interagency Monitoring Program have carried out extensive, long-term studies of the basin. The research is multi-disciplinary; it includes geology, soil science, hydrology, and limnology (the science of freshwater lakes and streams, covering both physical and biological properties).[2]

As a result, a rich body of information, which the District Court expressly termed "credible" (App. at 82), provides a baseline for examining the ongoing changes to the lake and predicting the outcome of current trends. Furthermore, since the date of the trial new analyses have further documented these changes.[3]

---

2. *See* Robert G. Wetzel, *Limnology: Lake and River Ecosystems* (2001).

3. *See* Alan D. Jassby, Charles R. Goldman, John E. Reuter, Robert C. Richards, and Alan C. Heyvaert, *Lake Tahoe: Diagnosis and Rehabilitation of a Large Mountain Lake*, in Great Lakes of the World; Food-Web, Health and Integrity (2001) (reviewing the main limnological findings to date for Lake Tahoe).

B. Five Principal Scientific Facts Concerning the Lake's Ecology, Which the District Court Recognized in Its Factual Findings, Underlie the Threats to the Lake.

1. Increased Deposits of Nitrogen and Phosphorus Are Causing the Lake To Change From an Oligotrophic to a Eutrophic Condition.

Lake Tahoe is unique because of its size, depth, and clarity.[4] Even as of 1981, well after Lake Tahoe's degradation had begun, the lake was classified among the clearest large lakes in the world. Few large lakes fall into this class.[5]

It is axiomatic that conditions outside of a lake affect its ecology.[6] Until mid-century, Lake Tahoe was "oligotrophic," *i.e.*, very low in nutrients, clear, and lacking a steep temperature gradient that would prevent deep circulation and mixing. Since then, however, the lake has been changing toward a "eutrophic" condition, a process characterized by

4. *See* Charles R. Goldman and Alexander J. Horne, *Limnology* 395, 401 (1983).

5. *See* Gerald A. Cole, *Textbook of Limnology* 192, Table 9-2 (4th ed. 1994).

6. W. Thomas Edmondson, *The Uses of Ecology: Lake Washington and Beyond* 59 (1991) ("The biological character of a lake is affected by a set of interconnected physical and chemical influences from outside."). Dr. Edmondson, who was one of the world's leading authorities on lakes, was one of the present group of Amici in the brief filed before the court below in this matter. He has since passed away.

an increase in algal growth.[7] As algae grows during eutrophication, the lake's clarity is reduced, and oxygen is depleted in the lake's depths. Fish and their habitat also are directly harmed. Since the time of trial, additional analyses have documented the continuing decline in the lake's transparency and its related ecological health.[8]

The process of eutrophication is scientifically well-understood. Nitrogen and phosphorus combine with carbon during photosynthesis to produce algae.[9] A critical result of excessive algal production is depletion of oxygen in water, a condition that jeopardizes the survival of fish.[10] This condition is already detectable in the waters near the bottom of Lake Tahoe.

As the evidence at trial indicated, natural eutrophication would take tens of thousands of years. Transcript 4:749. In

7. G. Evelyn Hutchinson, *A Treatise on Limnology, Vol. 1* 284 (defining eutrophication) (1957).

8. *See* Alan D. Jassby, Charles R. Goldman, John E. Reuter, and Robert C. Richards, *Origins and Scale Dependence of Temporal Variability in the Transparency of Lake Tahoe, California-Nevada*, 44(2) Limnology and Oceanography 282 (1999) (discussing seasonal changes in the transparency of Lake Tahoe).

9. *See, e.g.*, Stanford L. Loeb, *Algal Biofouling of Oligotrophic Lake Tahoe: Causal Factors Affecting Production*, in *Algal Biofouling*, 159, 171 (L.V. Evans and K.D. Hoagland ed. 1986).

10. Goldman & Horne, *supra* n.4, at 265 ("One of the most serious effects of eutrophication in lakes is its effect on depleting oxygen in the hypolimnion. This may result in the loss of deepwater spawning grounds and the elimination of some benthic invertebrates for food . . ."). *See also id.* at 97-98, 266-67.

Lake Tahoe, however, algal growth is increasing rapidly at the alarming average rate of 5% per year. Transcript 4:763. Significant amounts of the nutrients nitrogen and phosphorus, the "fertilizer" that produces algae, are being transported into the lake.[11] The data indicates that phosphorus is now the most critical or "limiting" factor in algal production; the lake currently contains sufficient amounts of nitrogen to increase algal formation above present rates if additional phosphorus becomes available.[12]

Amici emphasize that the increased algal formation from nutrients, with its concomitant threat to the lake's unique clarity, fish, and wildlife, is not a hypothesis. It has been documented scientifically and is well underway.

2. Human Development in the Lake Tahoe Basin is Causing The Damaging Increase in Nutrient Levels.

The District Court found that "[t]he evidence clearly shows that this increase in nutrient levels is caused by increased development in the Lake Tahoe Basin." App. at 63. Given the basin's ecology, this conclusion is irrefutable.

11. Robert N. Coats and Charles R. Goldman, *Patterns of Nitrogen Transport in Streams of the Lake Tahoe Basin, California-Nevada*, 37 Water Resources Research 405-15 (2001) (analyzing ten years of data on nitrogen transport at Lake Tahoe).

12. Charles R. Goldman, Alan D. Jassby, and Scott H. Hackley, *Decadal, Interannual and Seasonal Variability in Enrichment Bioassays at Lake Tahoe, California-Nevada, USA*, 50 (7-8), Can. J. Fish, Aquat. Sci. 1489, 1491 (1993) ("the long term [data] therefore indicate that a shift has taken place from colimitation by N and P to limitation primarily by P.").

Research has firmly established the nexus between development of environmentally sensitive lands and increased nutrient levels in lakes.[13] All of the lands within TRPA's jurisdiction drain into Lake Tahoe. Artificial disturbance of land greatly increases the supply of nutrients to streams, and those streams in turn transport the elevated nutrient loads to the lake.[14]

This disturbance occurs in a variety of ways.[15] Of foremost importance is the destruction of vegetation. Vegetation holds nitrogen in place, preventing it from

13. *See, e.g.*, W.M. Lewis, J.F. Saunders III, D.W. Crumpacker, Sr. & C. Brendecke, *Eutrophication and Land Use: Lake Dillon, Colorado* (1984) 3 ("[R]elatively little human presence or human activity is required to double or triple the total phosphorus concentrations" in Lake Dillon) and 145-48 (analyzing the phosphorus and nitrogen yields from various levels of development); T. Hirose and N. Kurmoto, *Stream Water Quality as Influenced by Land Use Patterns in the Kakioka Basin, Japan*, 10 J. Environ. Qual. 184 (1981).

14. *See* R.C. Loehr, *Characteristic and Comparative Magnitude of Non-point Sources*, 46(8) J. Water Pollut. Control. Fed. 1849 (1974); Thomas Dunne and Luna B. Leopold, *Water in Environmental Planning* 508 (1978) ("In its natural state, the soil covering a hillslope remains in a state of approximate equilibrium for a very long period of time") and 510 ("Human occupance of land almost always increases the rate of hillslope erosion by significant and sometimes catastrophic amounts").

15. *See* Tahoe Regional Planning Agency, *Study Report for the Establishment of Environmental Threshold Carrying Capacities* (October 1982) (Defendants' Exhibit 237); Luna B. Leopold, M. Gordon Wolman, and John P. Miller, *Fluvial Processes in Geomorphology* 47-48 (1964). The removal of vegetation and exposure of the soil is especially critical. *Fluvial Processes*, 47 ("The data . . . show that for a given precipitation the quantity of sediment eroded from fallow land or land in row crops is roughly 80 times the amount eroded from grasslands.").

leaching from the soil into the streams and the lake. Vegetation also protects against erosion of soil particles, which constitute the lake's primary source of phosphorus. When the natural vegetation is removed by development, both the loss of nitrogen storage and erosion of phosphorus-rich soil greatly accelerate the transport of nutrients to Lake Tahoe.

The creation of impervious surfaces such as roads likewise hastens the flow of nutrients to the lake. Impervious surfaces prevent rain and snowmelt from seeping underground where plant roots can strip out the nitrogen. Instead of water moving to the lake as groundwater, precipitation becomes nitrogen-rich surface flow. Furthermore, because the velocity of surface flow far exceeds that of groundwater, the flow of nutrients is vastly accelerated.

The characteristics of the chemical phosphorus contribute to this erosive cycle. Phosphorus adheres tightly to sediment and is adsorbed onto sediment particles. As a result, when disturbances to land increase the amount of sediment, a corresponding increase will occur in the amount of phosphorus reaching the lake.[16] A close relationship also exists between sediment yield from watersheds and the phosphorus in that sediment. Research has found a marked increase in the phosphorus concentration in streams located in developed areas.[17]

---

16. Lorin K. Hatch, John E. Reuter and Charles R. Goldman, *Stream Phosophorus Transport in the Lake Tahoe Basin, 1989-1996*, in *Environmental Monitoring and Assessment*, 69 Environmental Monitoring and Assessment 63-83 (2001) (discussing delivery of phosphorus to the lake).

17. Earl R. Byron and Charles R. Goldman, *Land-Use and Water Quality in Tributary Streams of Lake Tahoe, California-Nevada*, (Cont'd)

Given the relationship between disturbance of land and the flow of nutrients to the lake, an increase in algal formation will occur in areas of the lake located near development projects. As Dr. Goldman testified at trial, the maximum planktonic algal growth found in his research was located near areas of intense development. Transcript 4:774. Thus, the District Court correctly concluded that "algal growth is more noticeable in areas of the lake near larger concentrations of human habitat and development." App. at 63.

3. Development of "High Hazard Lands" and "Stream Environment Zones" Poses the Greatest Threat to the Lake.

A third scientific principle central to the present case is that the amount of harm caused by development will vary with land characteristics. The types of land susceptible to greater erosion, and thus to increased delivery of nutrients to lakes, are well-known. The principal characteristic is steepness of slope. As land gets steeper, the velocity of water running off of it increases, and with it the erosive force of that water. Thus, steeper lands present a significant danger to Lake Tahoe, as field sampling at Lake Tahoe has demonstrated.[18]

(Cont'd)
18 J. of Envtl. Quality 84, 86 (1989). The research analyzed monitoring data for ten streams entering Lake Tahoe. The watersheds of these streams contained both High Hazard and Low Hazard lands with varying degrees of disturbance, and land covered by impervious surfaces from urbanization. Figures 1 through 4 show that disturbed/covered High Hazard lands deliver significant increases in nitrite-N, nitrate-N, soluble reactive phosphorus, and total phosphorus.

18. *See, e.g.*, *Water in Environmental Planning*, *supra* n.14, 511 ("Rainsplash erosion is particularly important on steep slopes devoid (Cont'd)

Another key factor is soil quality. Some soils shed water easily, while others tend to absorb water. Obviously, as soils repel more water, the potential for more nutrients to reach the lake increases.

These principles underlie the land use classifications used by TRPA.[19] Those classifications are based on environmental characteristics: slope, soil type, vegetative cover, and geomorphic context. *See* App. at 66. The "High Hazard" lands have characteristics that make them much more susceptible to erosion and transportation of sediment containing nutrients.[20]

Moreover, a specific type of wetland area, the "Stream Environment Zone" ("SEZ"), plays a special role in introducing nutrients to lakes. SEZ lands, which typically are marsh-like in

---

(Cont'd)
of vegetation . . ."); *Fluvial Processes in Geomorphology*, *supra* n.15, 359 ("Erosion by surface runoff might be expected to be greatest on long steep slopes with low infiltration capacity. Empirical data . . . appear to verify this.").

19. *See* Robert G. Bailey, *Land Capability Classification of the Lake Tahoe Basin, California-Nevada* (U.S. Dep't of Agriculture, Forest Service) (1974) (ER 11). This report and accompanying map describe the scientific basis for TRPA's classification of lands according to their relative capacity to withstand and recover from impacts of urban development (*i.e.*, de-vegetation, grading, trenching, and creation of impervious surfaces).

20. *Land-Use and Water Quality in Tributary Streams of Lake Tahoe, California-Nevada*, *supra* n.17, 86 ("Under conditions of increasing degree of human disturbance . . . the extent of disturbance is significantly related to runoff water quality . . .") This study is based upon direct measurement of water runoff from lands with varying capability hazard designations.

nature, act as storehouses for nutrients. Disturbance of SEZ lands releases stored nutrients, causing direct harm to the lake.

Additionally, as storm water spreads over these wetlands, they tend to filter out nutrients,[21] particularly phosphorus. Because phosphorus attaches itself to soil, the filtering and settling function performed by SEZ lands provides an important barrier against the deposit of more phosphorus into Lake Tahoe. Thus, TRPA's recognition of the dangers posed by disturbance of High Hazard and SEZ lands is entirely justified.

4. If These Adverse Ecological Changes Had Not Been Addressed, They Would In Practical Terms Have Become Irreversible.

The processes described above have been observed in other lakes throughout the world and are generally well-understood.[22] Human-induced eutrophication has led to the degradation and, in some cases, the destruction of similar valuable environments throughout the world. For example, the Zurich See experienced problems like those at Lake Tahoe[23], as have lakes in Canada and the Eastern United States.[24]

---

21. *A Treatise on Limnology*, *supra* n.7, 231 (defining the role of wetlands).

22. *See, e.g.*, Alexander J. Horne and Charles R. Goldman, *Limnology* 104-06 (2d ed. 1994) (discussing how erosion caused by human activity supplies sediment to receiving waters) and 509 ("Two prominent features of eutrophication are excess nutrient levels and low oxygen content of lake bottom waters.")

23. *See, e.g.*, L. Minder, *Studien Uber den Sauerstoffgehalt des Zurichsees*, 3 Arch. Hydrobiol. Suppl. 107 (1923).

24. John R. Vallentyne, *The Algal Bowl: Lakes and Man*, in 2 Misc. Special Publ., Fisheries and Marine Service, Environment Canada (1974).

In the present case, the District Court concluded that if the ecological processes affecting Lake Tahoe continue, the changes will become irreversible. App. at 62. This conclusion is inescapable for two reasons. First, the lake will retain additional nutrients deposited in it for at least 70 years, with water exchanging over a period of about 700 years. This long retention period greatly hinders, and in all likelihood prevents, meaningful remedial efforts. Transcript 4:750.

Moreover, an important reaction will occur at some point in the lake's process of algal development. As algal growth increases, lack of oxygen near the lake bottom will cause a ferric iron "cap" located there to become soluble ferrous oxide. Thereafter, a so-called "autocatalytic reaction" is highly likely. In that reaction, great amounts of nutrients, currently "locked-in" by the ferric iron cap, will be released from sediments at the lake's bottom, increasing the rate of algal growth. As Dr. Goldman testified, once that reaction occurs, the lake will be irremediably damaged. Transcript 4:750. The deep waters will no longer support lake trout, the lake's most important sports fish. Transcript 4:751-52. There is already measurable evidence of the decline of oxygen in the lake's deep water.

5. The Change to the Lake's Color Is Merely One Visible Sign of the Fundamental Transformation of the Lake's Ecology.

The most apparent sign of change to Lake Tahoe is the loss of about one-third of its transparency in the last 40 years.[25]

25. Charles R. Goldman, *Anthropogenic Impacts on Oligotrophic Lake Systems Emphasizing Lakes Tahoe and Baikal*, in *Environmental Protection and Lake Ecosystems*, 385-98 (H. Sund and Y. Xiaogan eds. 1994).

Amici emphasize, however, that this loss of transparency is only one visible sign of the ongoing ecological changes to the lake. Nutrient loading from the surrounding watershed is causing increased algal growth and a progressive loss in transparency. The inorganic turbidity created by the discharge of small particles into the lake is further reducing transparency.[26]

Other evidence of algal growth is the presence of floating mats of periphyton (*i.e.*, previously attached algae) that did not appear before in the lake. The algae threatens changes to fish populations, particularly to important salmonid species. When algae dies, it decomposes and emits a "rotten-egg" smell. Finally, blooms of attached algae have washed up on beaches and in marinas on the lake.

II. THE SCIENTIFIC EVIDENCE OF THE LAKE'S INCREASING DEGRADATION COMPLICATES THE PLANNING RESPONSE AND JUSTIFIES THE NEED FOR A MORATORIUM IN WHICH TO COMPLETE THAT PLANNING.

In *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992), this Court adopted a *per se* rule for regulatory takings in situations where a landowner was deprived of all

26. *See Origins and Scale Dependence of Temporal Variability in the Transparency of Lake Tahoe, California-Nevada*, *supra*, n.8, at 289 ("... [T]he snowmelt in the spring results in increasing streamflow and increasing suspended sediment discharge to the lake."); *see generally* Charles R. Goldman, *Primary Productivity, Nutrients, and Transparency During the Early Onset of Eutrophication in Ultra-Oligotrophic Lake Tahoe, California-Nevada*, 33(6 part 1) J. of Limnology and Oceanography 1321, 1331 (1988).

economic use of his or her property. In doing so, the *Lucas* opinion explained why justifications for the regulation would be irrelevant to a takings analysis in such situations. Most importantly, the Court first identified what it termed the "functional basis" for permitting government regulation that affects property values: that "[g]overnment hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law . . ." *Id.* at 1003 (citing *Pennsylvania Coal Co. v. Mahon*, 260 U.S. at 413). However, the Court then concluded that this functional basis for regulation did not apply "to the relatively rare situations where the government has deprived a landowner of all economically beneficial uses." *Id.*

Petitioners now seek to extend the *per se* rule adopted in *Lucas* to all moratoria, which by definition deprive a landowner of the property's use for a limited period of time. *Amici* submit that the scientific evidence concerning the peril faced by Lake Tahoe demonstrates why such an extension would imperil the planning process and thereby jeopardize, in the words of *Lucas*, the "functional basis" of regulation.

First, the evidence indicated that the threat to the lake's renowned clarity arises from development activities around the lake, and that some lands pose more of a threat to the lake than others. To accurately address the threat, and to minimize regulation on lands that do not pose a threat, TRPA needed very precise information about the characteristics of all land surrounding the lake. In short, the information-gathering part of the regulatory process was necessarily extensive.

Second, the science dictated that the regulatory body would have to make difficult choices. TRPA was required to determine which lands posed the greatest threat to the lake and how the regulatory burden should be distributed. This task, which required significant public input, necessarily required some time to complete. The District Court, in an unchallenged finding, expressly concluded that the amount of time spent by TRPA in completing its work was reasonable. App. at 115.

Third, the scientific evidence indicates that TRPA had little, if any, margin for error in formulating the regulatory plan. The lake, crystal clear for thousands of years, is currently losing is clarity at the truly alarming rate of 5% per year. Unless the agency chose the correct instruments to arrest this decline, the scientific evidence indicated that additional damage would inevitably occur.

In that event, the decline in the lake's clarity would be virtually irreversible. There would be no "second chance."

Finally, unless TRPA could prevent development while it completed its planning, the likelihood of saving the lake from precipitous degradation would be greatly reduced. Faced with the prospect of impending regulation, landowners would likely "rush to develop" in the absence of a moratorium. The new development would inevitably cause an increase in the discharges to the lake, thus further complicating the regulatory effort. At the same time, the agency's resources would be divided between a planning effort designed to comprehensively address the lake's future, and a need to process a flood of individual development approvals.

Courts have upheld development moratoria for over 75 years. In many of those cases, they have observed that a moratorium may be necessary to preserve the integrity of the planning process being undertaken and to avoid a "rush to develop" that would undermine the very plan being created. *See, e.g., State ex rel. SCA Chemical Waste Services, Inc. v. Konigsberg*, 636 S.W.2d 430, 434 (Tenn. 1982) ("it would be destructive of the plan if, during the period of its incubation and consideration, persons seeking to evade its operation could be permitted to enter upon a course of construction that would progress so far as to defeat, in whole or in part, the ultimate execution of the plan"); *City of Dallas v. Crownrich*, 506 S.W.2d 654, 660 (Tex. App. 1974) (upholding an interim prohibition on building permits to avoid "a race of diligence to the city hall by property owners attempting to place structures upon their land that would be out of accord with the surrounding property under the new zoning laws"); and *Downham v. City Council of Alexandria*, 58 F.2d 784, 788 (E.D. Va. 1932) (without interim regulation, "any movement by the governing body of a city to zone would, no doubt, frequently precipitate a race of diligence between property owners, and the adoption later of the zoning ordinance would in many instances be without effect . . . like locking the stable after the horse is stolen.") *See generally* Julian Conrad Juergensmeyer and Thomas E. Roberts, *Land Use Planning and Control Law* 233 (1998) ("Protection of the planning process requires this [interim ordinance freezing development] for without it developers could defeat the plan before it begins by inconsistent vested uses.") In short, to use the terminology of *Lucas*, courts have upheld moratoria to ensure the "functional basis" of regulation.

Before this Court concludes that the hundreds of moratoria imposed by local governments in the aid of planning actually effected takings, the Court must carefully

consider the impact of such a ruling on the government's ability to regulate effectively. The scientific evidence concerning Lake Tahoe leads to only one conclusion: such a ruling would gravely jeopardize TRPA's ability to act decisively and effectively in a manner that would preserve the lake.

CONCLUSION

For the foregoing reasons, the decision of the Court of Appeals should be affirmed.

Respectfully submitted,

KARL M. MANHEIM*
DANIEL P. SELMI
Attorneys for Amici Curiae Scientists
919 S. Albany Street
Los Angeles, California 90015
(213) 736-1106

**Counsel of Record*